REMARKS

This Amendment is filed in response to the Office Action mailed on December 29, 2006. All objections and rejections are respectfully traversed.

Claims 1-22, 38, 40-41, 43-44, 46, 55-83 are currently pending.

Claims 82-83 are added.

Request for Interview

The Applicant respectfully requests a telephonic interview with the Examiner after the Examiner has had an opportunity to consider this Amendment, but before the issuance of the next Office Action. The Applicant may be reached at 617-951-3067.

Double Patenting Rejection

At paragraphs 4 of the Office Action, claims 1-4, 10-11,17-18, 20-21, 38, 40, 41,43, 44, 55-56, 62, 64, 69, 71-73, 76, and 77-81 were rejected on the ground of non-statutory obviousness-type double patenting as being unpatentable over U.S. Patent No. 6,851,082.

Applicant respectfully urges that the conflicting patent 6,851,082 and the present application are commonly owned. Accordingly, a terminal disclaimer has been timely filed herewith in compliance with 37 C.F.R. 1.321 to overcome the rejections based on the non-statutory double patenting ground.

Claim Rejections – 35 USC § 103

At paragraphs 5 of the Office Action, claims 1-6, 8-12, 14-22, 55-58, and 61-81 are rejected under 35 U.S.C. §103 as being unpatentable by Stallmo et al., US Patent No. 6,052,759, issued on April 18, 2000, hereinafter Stallmo, over Baylor et al., US Patent No. 5,862,158, hereinafter Baylor

The present invention, as set forth in representative claim 1, comprises in part:

> 1. A method for enabling parity declustering in a balanced parity array of a storage system, comprising:
> ***combining a plurality of unbalanced parity stripe arrays, each unbalanced parity stripe array storing an unequal number of parity blocks per disk, to form the balanced parity array, the balanced parity array storing substantially the same number of parity blocks on all disks, each unbalanced parity stripe array and the balanced parity array having parity blocks on a set of storage devices that are disjoint from a set of storage devices storing data blocks***; and
> ***distributing assignment of storage devices to parity groups throughout the balanced parity array***.

By way of background, Stallmo describes a redundant array of independent disks (RAID) system for organizing data across a single array of disks when disks are added and removed. Stallmo's process of combining parity (Fig. 12, 14 and 15) onto a single disk requires swapping parity blocks and data blocks to go from a RAID 5 implementation to a RAID 3 implementation. (Col. 14, lines 19-22). Stallmo performs this change to allow for a disk to be added or deleted from the array. Furthermore, Stallmo organizes the disks into "rectangles" where each rectangle has the same number of blocks on each disk with the first "rectangle" equal to the number of blocks in the disk with the smallest number of blocks. The disk may have more than one rectangle with except for the smallest disk. (Col. 8, lines 45-51). The "rectangles" are organized into "squares", where the number of blocks in each "square" is equal to the number of disks in the rectangle multi-

plied by the depth. (Col. 9, lines 14-20) The depth is set by the sub-system software and equal to the number of blocks that are necessary for each read or write operation. (Col. 2, lines 13-17). Stallmo organizes the data into rectangles to transform unstriped unprotected data into striped data or if data and parity are involved to transform from protected unstriped to protected striped.

Baylor discloses a method for storing redundant information in array of storage devices. Each data block is assigned to two different parity sets. Each parity set is stored in one parity block on separate disks of the array. In other words, each disk in the array has exactly one parity block storing one parity set of information.

Applicant respectfully urges that Stallmo and Baylor, taken alone or in combination do not disclose nor suggest Applicant's claimed novel ***combining a plurality of unbalanced parity stripe arrays, <u>each unbalanced parity stripe array storing an unequal number of parity blocks per disk</u>, to form the balanced parity array, the balanced parity array storing substantially the same number of parity blocks on all disks, each unbalanced parity stripe array and the balanced parity array having parity blocks on a set of storage devices that are disjoint from a set of storage devices storing data blocks*** and ***distributing assignment of storage devices to parity groups throughout the balanced parity array***. In further detail, Applicant's invention is combining unbalanced parity arrays from separate RAID arrays to form super stripes that have balanced parity arrays. The storage devices that contain data are separate (***disjoint***) from the storage devices that contain parity. The plurality of storage devices containing parity form a parity array, which is a subset of all the disks in each RAID array. Specifically, the system combines

an ***unbalanced stripe*** which has ***an unequal number of parity blocks per disk*** with at least one other unbalanced stripe having ***an unequal number of parity blocks per disk*** to form a balanced parity array of which stores ***substantially the same number of parity blocks on all disks***.

By ***distributing assignment of storage devices to parity groups throughout the balanced array***, enables Applicant's invention to handle single and double disk failures. Additionally, the number of accesses to each number of disks is reduced by distributing the parity for two separate sets of data across all disks. (See Specification page 28, line 14 to page 29, line 2, Fig. 14).

In contrast, neither Stallmo nor Baylor discloses use of a separate ***parity array***. Stallmo discloses either spreading parity across all disks of the RAID array (i.e. RAID 5) or a single disk containing all parity (i.e. RAID 3). When Stallmo discloses combining parity into a single disk for adding or removing a disk (switching from RAID 5 to RAID 3), Stallmo describe swapping parity disk assignments with data assignments. In other words, Stallmo is moving data to align all parity blocks on a single disk. There is no disclosure of using multiple parity disks in Stallmo, nor any suggestion because a single disk of parity is sufficient for single disk failures. Stallmo does not suggest or disclose double disk failures. Baylor does disclose recovery for double disk failures, however, Baylor does not disclose a separate parity array. Baylor discloses storing exactly one parity block on each disk, where the one parity block stores the parity for one parity set. (See Col. 4, lines 18-28, table 1). Neither Baylor nor Stallmo disclose a separate parity array,

where the parity array is across a plurality of disks with each disk storing just parity blocks.

Additionally, the combination of Stallmo and Baylor does not suggest a parity array because both suggest storing parity across all disks with data. Baylor does not suggest a separate parity array. Stallmo merely discloses a single disk of parity in order to add a disk. There is no disclosure of combining separate unbalanced parity arrays because neither teaches of disjoint (separate) parity arrays.

Applicant respectfully urges that the Stallmo patent and the Baylor patent, either taken singly or taken in any combination are legally insufficient to render the presently claimed invention obvious under 35 U.S.C. § 103 because of the absence in each of the cited patents of Applicant's claimed novel ***combining a plurality of unbalanced parity stripe arrays, each unbalanced parity stripe array storing an unequal number of parity blocks per disk, to form the balanced parity array, the balanced parity array storing substantially the same number of parity blocks on all disks, each unbalanced parity stripe array and the balanced parity array having parity blocks on a set of storage devices that are disjoint from a set of storage devices storing data blocks*** and ***distributing assignment of storage devices to parity groups throughout the balanced parity array***.

At paragraph 6 of the Office Action, claims 38, 40-41, 43-44, and 46 were rejected under 35 U.S.C. §103 as being unpatentable over Burton et al. US Patent Application Publication 2003/0074527, filed on April 17, 2003, in view of Stallmo.

The present invention, as set forth in representative claim 38, comprises in part:

> 38. A method for declustering a parity array having a plurality of storage devices, comprising:
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> ***assigning a first plurality of data and parity blocks to a first group, where the data blocks are stored on a plurality of storage devices that are disjoint from a plurality of storage devices storing parity blocks to form a first parity group, wherein the parity blocks are striped across the plurality of storage devices in the first parity group with an uneven number of parity blocks per each storage device***;
>
> ***assigning a second plurality of data and parity blocks to a second group, where the data blocks are stored on a plurality of storage devices that are disjoint from a plurality of storage devices storing parity blocks to form a second parity group***, wherein the parity blocks are striped across the plurality of storage devices in the second parity group with an uneven number of parity blocks per each storage device, wherein the first and second parity groups being independent from each other; and
>
> ***combining the first parity group and the second parity group to form a balanced parity array, the balanced parity array storing substantially the same number of parity blocks on the storage devices configured to store parity***.

By way of background, Burton describes a system for a user to create a span of disks. The system wants a balanced number of disks in each span to maximize cache utilization. With more disks per span, fewer stripes are necessary to store all the cache information.

Applicant respectfully urges that Burton and Stallmo taken alone or in combination do not teach nor suggest Applicant's claimed ***assigning a first plurality of data and parity blocks to a first group, where the data blocks are stored on a plurality of storage devices that are disjoint from a plurality of storage devices storing parity blocks to form a first parity group, wherein the parity blocks are striped across the plurality of storage devices in the first parity group with an uneven number of parity blocks per each stor-***

age device *... assigning a second plurality of data and parity blocks to a second group, where the data blocks are stored on a plurality of storage devices that are disjoint from a plurality of storage devices storing parity blocks to form a second parity group ...combining the first parity group and the second parity group to form a balanced parity array, the balanced parity array storing substantially the same number of parity blocks on the storage devices configured to store parity*. In further detail, Applicant's invention arranges the disks to have data disks and parity disks, where the parity disks form a parity array. The parity disks are separate disks from the data disks. A first parity group is stored on the parity disks of the first unbalanced parity array, where the first parity array stores parity blocks for a first RAID group. The second parity group is stored on the parity disks of the second unbalanced parity array, where the second parity array stores parity blocks for a second RAID group. There are gaps in locations of where parity is stored for example with an even number of disks (n) there can be no delta of n/2 because if two disks were half the length of the array apart were lost then, the data blocks members of the same two parity sets are lost, thereby obviating recovery of the lost data. (Specification page 20, line 1-26). When the two groups are combined, a balanced parity array forms combining an unbalanced parity array from first parity group and the second parity group.

In contrast, there is no disclosure in either Stallmo or Burton of using a parity array, or a plurality of disks for storing parity. Specifically, there is no suggestion in Stallmo because it only discloses single disk failure which only requires a single disk of parity to protect the data. Additionally, Stallmo also discloses rotating the parity through

all disks instead of just storing all the parity on a single disk. Furthermore, Burton only describes balancing the number of disks in each span and not combining parity groups to form a balanced array with approximately the same number of blocks per all disks. Additionally, neither discloses combining parity blocks from separate parity arrays to form a balanced parity array with parity blocks from two separate RAID groups.

Accordingly, Applicant respectfully urges that the Stallmo patent and the Burton patent, either taken singly or taken in any combination are legally insufficient to render the presently claimed invention obvious under 35 U.S.C. § 103 because of the absence in each of the cited patents of Applicant's claimed novel ***assigning a first plurality of data and parity blocks to a first group, where the data blocks are stored on a plurality of storage devices that are disjoint from a plurality of storage devices storing parity blocks to form a first parity group, wherein the parity blocks are striped across the plurality of storage devices in the first parity group with an uneven number of parity blocks per each storage device*** *...* ***assigning a second plurality of data and parity blocks to a second group, where the data blocks are stored on a plurality of storage devices that are disjoint from a plurality of storage devices storing parity blocks to form a second parity group*** *...* ***combining the first parity group and the second parity group to form a balanced parity array, the balanced parity array storing substantially the same number of parity blocks on the storage devices configured to store parity***.

At paragraph 7 of the Office Action, claims 7, 13, and 59-60 were rejected under 35 U.S.C. §103 as being unpatentable over Stallmo, in view of Baylor, and in further view of Karr, US Patent No. 3,993,862, hereinafter Karr.

Applicant respectfully notes that claims 7, 13, and 59-60 are dependent claims that depend from independent claims believed to be in condition for allowance. Accordingly, claims 7, 13, and 59-60 are also believed to be in condition for allowance.

All independent claims are believed to be in condition for allowance.

All dependent claims are believed to be dependent from allowable independent claims.

The Applicant respectfully solicits favorable action.

Please charge any additional fee occasioned by this paper to our Deposit Account No. 03-1237.

Respectfully submitted,

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